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OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

April 16 - April 22, 1999

Summary 99-16

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EVENTS

1. RAISED DUMP TRUCK BED STRIKES OVERHEAD CONDUCTORS

On April 14, 1999, at the Argonne National Laboratory East, the raised bed of a dump truck driven by a subcontracted driver struck and severely damaged overhead conductors across a roadway. The conductors consisted of 120- and 480-V ac lines and communication cables serving telephone, fire alarm, public address, and security systems. The occurrence did not cause personal injury; however, it broke conductors, snapped a utility pole, damaged electrical switchgear mounted on the pole, damaged an electrical service entrance and the roof of a small outbuilding, and pulled cables from the service entrance to a utility trailer. (ORPS Report CH-AA-ANLE-ANLEAPS-1999-0003)

Site personnel immediately isolated power to the affected conductors. Investigators for this occurrence determined that the driver of the dump truck had been moving dirt for additional cover over a retired landfill. He had delivered a load of dirt, had reentered the roadway with the bed raised, and had driven approximately an eighth of a mile before striking the overhead conductors. Investigators also determined that a spotter assigned to the project had been involved in other activities at the time of the occurrence. Work planners had performed a hazard analysis, had identified the overhead cables as a hazard, and had included this information in pre-job briefings. The driver told investigators that he didn't realize the truck bed was up.

Because work procedures specifically required a spotter at the fill location, Argonne balance-of-plant managers suspended all subcontracted employees involved in the earthmoving project from the site for 6 months, except for the foreman, who was at the excavation site.

NFS has reported on several events involving vehicular contact with overhead cables or obstructions. Some of these events follow.

- Weekly Summary 99-05 reported that a Savannah River Central Services Works Engineering heavy equipment operator sustained minor injuries when the bed of a 16-yard dump truck she was driving collided with an overpass. Witnesses state that the bed of the truck rose shortly before it struck the overpass, and the driver of a vehicle behind the dump truck attempted unsuccessfully to alert the driver of the truck. The accident site is at least a 5-minute drive from the site from which the driver had departed with the bed lowered. Facility personnel estimated damages to the truck and overpass at more than $300,000. (ORPS Report SR--WSRC-CSWE-1999-0002)

- Weekly Summary 97-02 reported that an equipment operator at Savannah River inadvertently backed a front-end loader into a guy wire, causing it to break. The broken wire contacted and short-circuited a 13.8-kV transformer. Investigators determined that the work package did not address safe working distances from wires and that a spotter was not used during this activity. (ORPS Report SR--WSRC-SLDHZD-1996-0029)

- Weekly Summary 96-49 reported that at Argonne National Laboratory East, a dump truck with a raised bed snagged an overhead 120/240-V power line and communication lines as it was leaving the dump site. Investigators determined that a job-specific requirements form did not indicate an overhead line hazard and that no spotters were used. Corrective actions included modifying the form to include reviewing construction sites for overhead lines and designating spotters. (ORPS Report CH-AA-ANLE-ANLEPFS-1996-0009)

- Weekly Summary 96-46 reported that an equipment operator at the Idaho National Engineering Laboratory backed a forklift into a 480-V ac and 208-V ac overhead power bundle with the mast raised. The operator failed to use a spotter and failed to inspect the overhead area around the work location. Corrective actions included installing concrete barriers to prevent vehicle access near the lines and requiring supervisors to walk down areas to identify potential hazards. (ORPS Report ID--LITC-PBF-1996-0001)

- Weekly Summary 94-45 reported that a truck struck two overhead 13.2-kV lines at the Los Alamos National Laboratory while the driver was unloading asphalt in preparation for construction paving operations. The occurrence interrupted power to several buildings, including a plutonium processing facility. The driver had just dumped a load of asphalt and was moving the truck slowly forward when the extended bed struck the lines. One of the lines immediately severed, and the broken ends fell to the ground. The other line caught the underside of the extended truck bed but did not break. An individual working nearby who witnessed the event shouted to the truck driver to stay in the truck. The driver complied and avoided serious injury or death from electric shock. (ORPS Report ALO-LA-LANL-PHYSTECH-1994-0013)

Vehicular contact with overhead power lines presents a significant personnel safety hazard as well as a possible challenge to safety-related electrical distribution systems. A review of this event at Argonne and prior events reveals a pattern of preventable causes related to work planning and performance.

- Failure to provide or use spotters. Spotters should be required for all construction activity involving heavy equipment. Spotters should have no other duties while heavy equipment is in use. Operators should be prohibited from operating or moving equipment unless a spotter is present.

- Inadequate work planning. Work planners should inspect overhead hazards and clearances at job sites and over entire routes to be traveled by heavy equipment. Identified hazards should be described in work documents and thoroughly discussed in pre-job briefings.

- Failure to follow procedures or inattention to detail. Dump truck operators should be required to completely lower their truck beds before entering a roadway. All dump trucks should be equipped with audible and visual alarms in the cab to indicate that truck beds are not fully seated.

KEYWORDS: conductor, damage, overhead, truck

FUNCTIONAL AREAS: Construction, Work Planning

2. HIDDEN LEGACY CONTAMINATION DISCOVERED AT MOUND

On April 14, 1999, Mound Plant facility management reported that on March 25, 1999, radiation control technicians (RCTs) found a glass vial containing a black liquid in a fumehood that indicated 113,000 dpm by direct survey measurement. Isotopic analysis and gamma spectrometry identified the material in the vial as 0.8 μCi of uranium-235 and depleted uranium-238. Investigators believe the vial may have been left over from experiments conducted years ago and was overlooked during recent chemical roundups. This event and the discovery of hidden legacy contamination at Mound are the result of corrective actions developed in response to an event that occurred in February 1999. (ORPS Report OH-MB-BWO-BWO01-1999-0008)

OEAF engineers reviewed other events at the Mound Plant in which legacy contamination has recently been discovered. Each of these events occurred in different rooms at the Mound facility.

- On March 25, 1999, RCTs performing a survey inside a cabinet drawer discovered contamination from plutonium-238 and americium-241. The room with the contaminated cabinet was not posted as a Radiological Area but was within a Controlled Area. Investigators believe that a contaminated part was stored in the drawer when the room was posted as a Contamination Area. The contamination inside the drawer was not identified when posting for the area was downgraded nearly 20 years ago. (ORPS Report OH-MB-BWO-BWO01-1999-0006)

- On March 12, 1999, RCTs discovered contamination on the top of a bookcase that was identified as plutonium-238. Investigators determined that there is no record indicating that plutonium-238 was ever present in the room with the bookcase. However, the crawlspace above the room is known to contain plutonium-238 contamination, and the bookcase was located approximately 2 feet from a major ceiling leak that occurred 3 years ago. The top of the bookcase was not surveyed at the time of the ceiling leak, and the room was not posted as a Radiological Area before the contamination was discovered. (ORPS Report OH-MB-BWO-BWO01-1999-0007)

- On March 2, 1999, RCTs performing a survey inside the top drawer of a safe outside a Radiological Area discovered tritium contamination levels above the free release limits. Investigators determined that the safe had been used for nearly 30 years to store classified parts and documents. Until 1995, the room containing the safe was posted as a Contamination Area, and it is possible that contaminated classified parts were once stored in the safe. The contamination inside the safe was not identified when the posting for the room was downgraded 4 years ago. (ORPS Report OH-MB-BWO-BWO01-1999-0005)

- On February 24, 1999, at the Mound Plant, RCTs discovered radioactive contamination identified as plutonium-238 on the floor of a room. The contaminated room was in a Controlled Area but was not in a Radiological Area or a Radiological Buffer Area. The contamination was concealed beneath floor-mounted steel cabinets that had been in place for over 20 years. Six days before the contamination was discovered, the cabinets were removed from the room without being surveyed, placed in a trash dumpster that was collected by a contracted hauler, and deposited in a commercial landfill. The level of contamination that may have been on the cabinets is unknown. However, investigators believe that they may not have been contaminated, because subsequent monitoring of the worker who disassembled the cabinets and surveys of the tools used, a cart used to transport the cabinet parts, and the dumpster where the parts were placed before transport to the landfill all indicated no contamination. Investigators also believe that the legacy contamination on the floor was a result of a 1994 flooding incident in the building. Although alpha

contamination was detected in the water samples, radiological surveys of exposed surfaces were conducted for tritium only, and only the exposed surfaces were decontaminated. The areas concealed by the cabinets were not surveyed or decontaminated, and the radiological postings were not changed. (ORPS Report OH-MB-BWO-BWO01-1999-0004)

Facility management at the Mound Plant downgraded the classification of former radiologically controlled areas over a number of years. These reclassifications were governed by changing regulatory standards and DOE requirements. Procedures developed for the reclassification of radiological areas after the implementation of new standards should have considered the difference between the radiological control levels required by previous standards and those required by newer standards. Work that intrudes into previously unexposed areas should consider that additional surveys might be needed given the more limited scope of earlier surveys. For example, current facility, operations, and radiation protection personnel, as well as personnel responsible for radiological work planning and control, were unaware that the surveys that followed the flooding incident were nonintrusive and would not have detected contaminated concealed surfaces.

The discovery of hidden legacy contamination in other non-radiologically-controlled areas at the Mound Plant is the result of comprehensive corrective actions developed and recharacterization surveys performed in response to the February 24 event. Some of those corrective actions follow.

- Post the buildings containing the contaminated rooms as Radiological Material Management Areas (RMMA) and expand the use of personnel contamination monitors in those buildings.

- Perform comprehensive surveys of previously reclassified areas in the affected buildings.

- Evaluate controls on material and equipment in other buildings and post other buildings as RMMAs, as required.

- Place a hold on material and equipment for free release until RMMA determinations and surveys are complete.

- Revise the governing procedure to clarify the radiological survey requirements for intrusive work.

Facility managers and radiation protection personnel should be aware that downgrading posted Radiological Areas requires detailed and rigorous characterization surveys to ensure that contamination and radiation levels are below the levels specified by current standards. Any work in a Controlled Area that requires the penetration of walls, ceilings, or floors or the exposure of previously inaccessible areas should be evaluated by radiation protection supervision for potential radiological concerns. The results of those evaluations should emphasize radiological monitoring during the work and the use of appropriate personal protective equipment. Likewise, any waste in a Controlled Area generated from the structural modification of a building, including waste generated from dismantling or demolition activities, should be evaluated.

The following draft implementation guides for use with 10 CFR 835, *Occupational Radiation Protection,* provide guidance on radiological surveys and the radiological classification of facility areas and rooms.

- DOE G 441.9-1, *Radioactive Contamination Control and Measurement,* provides an acceptable methodology for establishing and implementing a contamination control and measurement program and requires special surveys to accommodate planned events such as maintenance or material movement.

- DOE G 441.10-1, *Posting and Labeling for Radiological Control,* requires a posting and labeling program to ensure that radiological hazards are adequately controlled to protect worker health and safety.

Both implementation guides can be accessed at http://www.explorer.doe.gov:1776/htmls/draft.html. More information about these contamination events and the reclassification of radiologically controlled areas can be obtained from Jerry Allison, Tritium Complex building manager, at (937) 865-4533.

KEYWORDS: characterization, decontamination and decommissioning, posting, radioactive contamination, survey

FUNCTIONAL AREAS: Decontamination and Decommissioning, Radiation Protection

3. WORKERS WASH DOWN ELECTRICAL EQUIPMENT WITH WATER HOSE

On April 13, 1999, at the Los Alamos National Laboratory, laborers washed down energized electrical equipment while cleaning two walls and the floor of an equipment room at the Plutonium Processing and Handling Facility. The Johnson Controls Northern New Mexico laborers were using a hose with running water to wash dirt from the walls and floor. Water from the hose splashed into a boiler control box, causing a circuit breaker to trip open. A facility operator found the tripped circuit breaker for the boiler control box. Although the laborers were not injured, they could have received an electrical shock, because the control box for the boiler was wired with 480-V circuits. (ORPS Report ALO-LA-LANL-TA55-1999-0018)

The laborers' supervisor had instructed them to clean the two walls and the floor. They had cleaned the equipment room floor on earlier occasions using a hose; however, this time they had been instructed to clean the two walls. The work was performed under a standing work order for cleanup of equipment rooms and the outside area/yard. The laborers started cleaning the room and then went to lunch. During the break, personnel in the facility control center detected ground faults in a fire alarm panel. Control center personnel assumed the faults were caused by maintenance being performed on a fire door. After the laborers returned to work, the control center received multiple fire panel ground faults and a boiler-down indicator. When a facility operator investigated, he saw water on the floor and notified the control center supervisor. The control center supervisor responded and found the laborers washing down the floor. He directed them to stop work. The supervisor also found water in the boiler control box and in the fire alarm pull boxes.

The facility manager conducted a critique of the event. He placed the standing work order for general cleaning, trash pickup, and lawn mowing on hold until it can be revised. Critique members determined that the work being performed was outside the scope of the work description and was being done as skill-of-the-craft. The laborers' supervisor did not provide any guidance on the hazards of electrical equipment or on the need to control water spray.

NFS reported the following events in the Weekly Summary where water entered electrical equipment during cleaning or maintenance activities.

- Weekly Summary 93-37 reported that workers at the Hanford Fast Flux Test Facility sprayed water and silt on electrical switchgear for a diesel generator, causing a battery ground fault. The workers were attempting to clear a clogged drain using a water hose and a 125-psi air lance. Investigators determined that the clogged drain resulted from debris and water that accumulated following a water wash-down of a building roof.

- Weekly Summary 92-20 reported that maintenance personnel at the Portsmouth Gaseous Diffusion Plant caused an electrical fault when water mist got on a process transformer. The result was a loss of power to seven cascade cells and auxiliary power systems. Maintenance personnel were cleaning building ventilation filters using a high-pressure water hose. Investigators determined that the cleaning method allowed moisture to build up inside the transformer cabinet. The cleaning instructions did not address the need to prevent water spray from getting on and in equipment while using a high-pressure water spray. (ORPS Report ORO--MMES-PORTOPERD-1992-0044)

These events show the importance of properly shielding equipment when performing cleaning operations involving water, chemicals, or abrasive materials (for example, sand). Work control supervisors need to survey work areas for potential hazards. They need to inform workers of these hazards, one example of which is water spray around energized equipment, and provide instructions for avoiding them. Electrical equipment can be de-energized or temporary barriers put in place, but awareness of the hazard, along with effective control of the source of water, could be sufficient to prevent injury or equipment damage. Personnel also need to recognize that water spray and mist can be drawn into equipment through ventilation louvers well away from the direction of the spray. For some electrical equipment, the design of the enclosure can protect against water spillage/leakage from above, but direct impingement, overspray, or splashing from below could still result in intrusion. Also, standing work orders for routine work activities may not be adequate to control every work situation and protect workers under all conditions.

KEYWORDS: electrical fault, electrical hazard, ground fault, hose, water

FUNCTIONAL AREAS: Hazards and Barrier Analysis, Work Planning

4. SECURITY POLICE OFFICERS VIOLATE PROCEDURES BY PLACING THEIR DOSIMETERS ON A TELEPHONE POLE

On April 9, 1999, at the Los Alamos National Laboratory, two security police officers removed their thermoluminescent dosimeters (TLDs) from their bodies and placed them on a telephone pole during the operation of a burst-type reactor at the Pajarito Laboratory. The security police officers were stationed in their vehicle, which was parked in a revetment near the reactor during the burst operation. The officers had decided to conduct their own experiment to see if their TLDs would have similar readings. This act was in violation of the radiological work permit (RWP). Health physics personnel will reconstruct the security officers' external exposure. (ORPS Report ALO-LA-LANL-TA18-1999-0005)

The Advanced Nuclear Technology group was conducting a deliberate operation of the burst assembly to determine the external exposures of security force personnel. The operation required security police officers to be stationed in various locations around the site. Advanced Nuclear Technology personnel conducted briefings for all involved personnel, including Protection Technology Los Alamos (security force) personnel, before the burst operation was performed. Included in the briefings was the requirement to wear a temporary TLD, in addition to the normally assigned TLD, as specified in the RWP. The temporary dosimetry was required by the RWP for two purposes: (1) collecting ALARA data for Protection Technology Los Alamos management and (2) collecting enough information to reassure security police officers about the dose levels they are exposed to during operations. All personnel involved in the operation signed the RWP, indicating that they had read, and understood, the requirements. After being issued the temporary TLDs, the security police officers went to their posts.

Investigators determined that before taking up their assigned positions, the two security police officers placed their TLDs on a telephone pole situated approximately halfway between their vehicle and the door to the reactor for the duration of the operation. Health physics personnel collected the temporary TLDs after the operation. Based on past burst operations, the officers' doses were expected to be between 0 and 6 mrem. However, the temporary TLDs measured exposures of 32 and 36 mrem. Because of the unexpectedly high exposures, Protection Technology Los Alamos conducted an inquiry. Protection Technology Los Alamos management disqualified the two officers as radiation workers and removed them from assignment at the facility. Investigators learned that the two officers had been concerned with the statistical difference between the TLD readings on their two normally assigned TLDs during previous operations while at their station. Price-Anderson Amendments Act (PAAA) personnel at the Laboratory are reviewing this event for Nonconformance Tracking System (NTS) reportability. The NTS provides a means for contractors to promptly report potential noncompliances and take advantage of provisions in the PAAA enforcement policy.

OEAF engineers reviewed another event this week involving the violation of an RWP at the Los Alamos National Laboratory. On April 13, 1999, at the Plutonium Processing and Handling Facility, two custodians were performing decontamination work inside a room without wearing respirators, as required by the RWP developed for the job. Radiological control technicians drew nasal smears from the custodians. The smears all indicated no detectable activity. The custodians were cleaning up some residual contamination (hot spots) following cleanup of a leak days earlier. Personal protective equipment for the job included level II anticontamination clothing and respirators. A copy of the RWP was posted on the door to the room. Investigators determined that the custodians were not aware of the respirator requirements. Also, when the custodians arrived at the job and asked the job supervisor what was needed, he told them to enter the room and mop the floor. There had been no pre-job discussion on the radiological conditions or the RWP requirements. (ORPS Report ALO-LA-LANL-TA55-1999-0019)

These events illustrate the need for workers to be accountable and consider the consequences of violating RWPs. RWPs state the requirements for dosimetry and personal protective equipment and describe the radiological conditions in the work area. This information can be used to determine stay-times and to identify other measures necessary to prevent or minimize personnel exposures. Personnel working at DOE facilities should have a continually questioning attitude toward safety issues. Each individual is ultimately responsible for complying with rules to ensure personal safety. Facility managers should communicate a sound policy, stressing that safety is of prime importance and that all personnel must exhibit an individual commitment to excellence and professionalism. Managers should ensure that radiological protection practices are followed and enforced.

DOE/EH-0256T, *U.S. Department of Energy Radiological Control Manual*, chapter 1, “Excellence in Radiological Control,” Part 2, “Leadership in Radiological Control,” provides the following guidance on worker attitude and responsibility.

- Article 122, “Worker Attitude,” states: "Minimizing worker radiation exposure can be achieved only if all persons involved in radiological activities have an understanding of and the proper respect for radiation."

- Article 123, “Worker Responsibilities,” states that trained personnel should recognize that their actions directly affect contamination control, personnel radiation exposure, and the overall radiological environment associated with their work. The first rule of worker responsibility is to obey posted, written, and oral radiological control instructions and procedures, including instructions on RWPs.

Chapter 3 of the Manual, “Conduct of Radiological Work,” Part 2, “Work Preparation,” provides the following guidance on the use of radiological work permits.

- Article 321, “Radiological Work Permits,” states that an RWP is an administrative mechanism used to establish radiological controls for intended work activities. The RWP informs workers of area radiological conditions and entry requirements and provides a mechanism to relate worker exposure to specific work activities. The RWP includes dosimetry requirements and protective clothing and respiratory protection requirements.

- Article 322, “Use of Radiological Work Permits,” states that workers shall acknowledge by signature or electronic means (for automated access systems) that they have read and understood the RWP and will comply with it prior to their first entry into the area and after any revisions to the RWP.

- Article 324, “Pre-Job Briefings,” states that the radiological conditions of the workplace and RWP requirements should be discussed during a pre-job briefing.

- Article 325, “Personal Protective Equipment and Clothing,” states that personal protective equipment shall be selected as prescribed by the controlling RWP.

10 CFR 835, *Occupational Radiation Protection*, subpart E, “Monitoring in the Workplace,” section 835.401, “General Requirements,” states that monitoring of individuals and areas shall be performed to verify the effectiveness of engineering and process controls in containing radioactive material and reducing radiation exposure. Section 835.402, “Individual Monitoring,” states that for the purpose of monitoring individual exposures to external radiation, personnel dosimetry shall be provided to and used by radiological workers.

KEYWORDS: dosimeter, external exposure, radiation protection, radiological work permit, respirator, security, thermoluminescent dosimeter

FUNCTIONAL AREAS: Radiation Protection

FINAL REPORT

This section of the OEWS discusses events filed as final reports in the ORPS. These events contain new or additional lessons learned that may be of interest to personnel within the DOE complex.

1. LESSONS NOT LEARNED FROM PAST EVENTS RESULT IN FREEZE DAMAGE TO FIRE SUPPRESSION LINE

On February 12, 1999, at the Los Alamos National Laboratory, freezing water in a wet-pipe fire suppression system caused a sprinkler head to break at a piping elbow in Wing 2 of the Chemistry and Metallurgy Research (CMR) facility. The fire suppression line is located within an office exhaust ventilation plenum that is on the roof of the wing. The flow of water from the damaged line actuated a fire alarm. Fire Department personnel isolated the leak and the damaged line was repaired. A similar event had occurred on December 4, 1997, in Wing 5 of the facility. An identical wet-pipe fire suppression line in the exhaust plenum on the roof of the wing froze, causing a sprinkler head to break and release water. In both events, exhaust fans that provided a supply of warm air into the plenums had been removed from service, and no precautions were taken by facility personnel to prevent freeze damage. (ORPS Reports ALO-LA-LANL-CMR-1999-0003 and ALO-LA-LANL-CMR-1997-0026)

Each wing of the CMR facility has two separate office exhaust ventilation systems that continually exhaust air from nonradiological office areas. The exhaust systems for Wings 2, 5, and 7 are equipped with high-efficiency particulate air (HEPA) filtration in plenums located on the roof of each wing. The exhaust systems in the other wings do not have plenums with filtration. The exhaust plenums are similarly constructed: each has three wet-pipe fire suppression lines and sprinkler heads. Two of the lines have a common isolation valve that is maintained closed to prevent HEPA filter damage from an inadvertent sprinkler discharge. The third line does not have an isolation valve, so water is continually available at the sprinkler head. When the exhaust fans are operating, warm office air continually flows through the plenum, preventing the water in the third fire suppression line from freezing. If the exhaust fan is off, the third fire suppression line could be damaged by freezing outdoor temperatures.

On January 27, 1999, CMR facility operators turned off an exhaust fan in Wing 2 for maintenance work. They took no precautions to prevent freeze damage to the third fire suppression line while the fan was off. On February 12, Fire Department personnel found water flowing from a damaged sprinkler head and piping elbow on the fire suppression line. As an interim corrective action, CMR facility management had operators place labels on the circuit breakers and motor control centers for the six exhaust fans. The labels warned of the potential problem with securing the fans during cold weather. Until long-term corrective actions are implemented, operations personnel will take appropriate action to prevent freeze damage if a fan has to be turned off. The site AHJ (Authority Having Jurisdiction) has approved the removal of the wet-pipe section that is subject to freezing for long-term corrective action. This will be accomplished using the change control and unreviewed safety question determination process.

The wet-pipe fire suppression lines were installed in the plenums in the 1970s, in accordance with National Fire Protection Association (NFPA) codes and standards. Because the designers considered the area inside the plenums to be a normally heated space with the exhaust fans operating continuously, they provided no protection against freeze damage if a fan was turned off. There have been several cases of freeze damage to wet-pipe fire suppression lines since 1970 in areas that were considered “normally heated spaces.” In January 1992, there was freeze damage to a wet-pipe line in a filter tower on the main floor of Wing 2 (ALO-LA-LANL-CMR-1992-0002). After repair, no provision was made for the prevention of future freeze damage. In November 1992, the same pipe broke again because of freeze damage (ALO-LA-LANL-CMR-1992-0037). Laboratory fire protection personnel determined that the pipe was not required and had it removed. In the lessons-learned section of both occurrence reports, CMR facility management, at that time CST-26, stated that wet-pipe sprinkler systems should be reevaluated periodically, and if they are in an area that can experience freezing temperatures, they should taken out or replaced with a dry-pipe system. The NFPA Fire Prevention Code, section 7-5.4, states: "Annually, prior to the onset of freezing weather, buildings with wet-pipe systems shall be inspected to verify that windows, skylights, doors, ventilators, other openings and closures, blind spaces, unused attics, stair towers, roof houses, and low spaces under buildings do not expose water-filled sprinkler piping to freezing and that adequate heat is available."

In spite of the lessons learned in the two occurrence reports and the NFPA requirements, neither CMR facility management nor Laboratory fire protection personnel reviewed the wet-pipe systems to determine if other freeze-damage vulnerabilities existed. As a result, the potential problems associated with the wet-pipe lines inside the six plenums were not identified and no provisions were made to prevent freeze damage to these lines if the exhaust fans are turned off during cold weather.

In 1994, DOE issued DOE O 4330.4B, *Maintenance Management Program*. Section 19.1.1 states that a program should be in place to prevent equipment and building damage because of cold weather at any nuclear facility that may be at risk. Section 19.1.3 states that the freeze protection plan should detail actions and requirements to assure protection of the equipment/facility from cold weather or freezing. As a minimum, the plan should ensure that wet-pipe sprinkler systems are reviewed for areas susceptible to freezing and that appropriate actions are planned, such as providing auxiliary heat, draining the system, and posting a fire watch. By December 1997, CMR management had not developed a freeze protection plan.

Following the December 1997 event that caused the pipe leak in the Wing 5 exhaust plenum, CMR facility management (then CST-26) committed to the Laboratory the following actions.

- Install a new sprinkler head in the plenum. As of January 1999, the new sprinkler head had not been installed.

- Install an isolation valve (interim measure) for the affected line. As of January 1999, the valve had not been installed.

- Initiate a design change to replace the wet-pipe system in the plenum with a dry-pipe system. As of January 1999, the design change had not been implemented.

- Develop a procedure to ensure that adequate freeze protection precautions are taken when the exhaust fan is turned off during cold weather. As of January 1999, the procedure had not been developed.

- Review the CMR fire suppression system to identify other potential freeze protection problems. As of January 1999, the review had not been performed and no provisions were made to prevent further freeze damage to the wet-pipe lines in the exhaust plenums in Wings 2, 5, and 7 if the exhaust fans are turned off during cold weather.

By late August of 1998, the Laboratory had developed an institutional freeze protection plan in response to the numerous incidents and occurrences at the Laboratory. The plan required each facility management unit (including CMR) to develop and implement a freeze protection program by the end of November 1998. The requirements of the plan were based on guidelines contained in section 19.1 of DOE O 4330.4B. As of January 1999, CMR facility management had not developed and implemented a formal freeze protection program. However, a set of freeze protection checklists was in use, although they were not in the form of an instruction.

CMR facility management had ample opportunity to ensure that adequate controls were developed and implemented to prevent the equipment damage that occurred on January 27, 1999. However, the actions taken to apply the lessons learned from past events and identify and correct all freeze damage vulnerabilities within the facility were insufficient. Although freezing outside temperatures are a recognized seasonal hazard, the CMR facility continues to experience equipment damage from cold weather. The causes of this occurrence have been categorized as follows.

- **Direct Cause** — management problem; inadequate administrative control. Freeze protection administrative controls were inadequate.

- **Contributing Cause** — management problem; policy not adequately defined, disseminated, or enforced. Formal freeze protection plan had not been developed and implemented.

- **Root Cause** — management problem; work organization/planning deficiency. Lessons learned from past events were not applied and corrective actions were not developed or implemented to prevent recurrence.

The current CMR facility management (now NMT-13) developed the following corrective actions to address the causes of this occurrence.

- CMR facility management submitted a formal request to permanently remove from service all sprinkler protection installed in the office area exhaust plenums located on the roof of the CMR facility. Laboratory Fire Protection Group personnel concurred with the request after reviewing pertinent fire protection codes and standards, Laboratory fire-protection-related commitments, the facility's fire hazards analysis, a walk-down of a representative configuration, and discussions with facility engineering staff.

- CMR facility management will have all sprinklers in the office exhaust plenums at the CMR facility permanently removed from service.

- CMR facility management reviewed the CMR fire suppression system to determine whether any other unmitigated freeze protection vulnerabilities exist.

- CMR facility management developed and implemented a formal freeze protection program for the CMR facility.

Although the freeze events described in this report had little impact on the facility, other freeze events at the Laboratory and in the DOE complex have cost millions of dollars and have had a significant programmatic impact. Freeze protection is not difficult and must be part of any facility's annual maintenance cycle.

NFS encourages managers to incorporate lessons learned into their programs and daily operations. Lessons learned are valuable only if the information learned from them is applied and shared within the facility, the site, and the DOE complex. DOE-STD-7501-95, *Development of DOE Lessons Learned Programs*, was designed to promote consistency and compatibility across programs. Both lessons learned and program managers should review the standard and incorporate applicable elements into their site programs. Managers, supervisors, and operators should review lessons learned documents for applicability, and the information should be used to improve operations and protect equipment and personnel.

KEYWORDS: exhaust fan, fire suppression, freeze protection, lessons learned, sprinkler, water, wet pipe

FUNCTIONAL AREAS: Lessons Learned, Operating Experience